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PATENT SPECIFICATION 862,350

DRAWINGS ATTACHED.

Inventor:—JAMES NEVILLE LOWE.

Date of filing Complete Specification : Dec. 18, 1959.

Application Date : Jan. 7, 1959. No. 664/59.
(Patent of Addition to No. 835,804, dated June 30, 1958).

Complete Specification Published : March 8, 1961.

Index at Acceptance :—Class 68(2), H(1A : 1D : 5).

International Classification : —E02d.

COMPLETE SPECIFICATION.

Improvements relating to Methods of Forming Foundations.

We, THE PRE-STRESSED CONCRETE COMPANY LIMITED, a British Company, of 171 Victoria Street, Westminster, London, S.W.1, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the founding of permanent structures in soil and is moreover an improvement in or modification of the invention described in the Specification accompanying our Application Nos. 22820/57, 30702/57 and 36703/57 (Serial No. 835,804).

According to one feature of our prior invention a permanent structure is founded in the following manner:—

A foundation block is held by a helicopter in a position above the surface of the soil in which the structure is to be founded, the block is caused to move downwards from the helicopter and is caused by kinetic energy acquired whilst the block is in movement above the surface of the soil to penetrate the soil to a depth at which it is able to carry the load imposed upon it by the structure and the structure is then supported on the block.

The foundation block may be allowed to fall from the helicopter under the action of gravity alone or it may be projected downwards, for example, by means of a rocket or rockets fixed to it. Considerable accuracy can be obtained in the positioning of a foundation block projected or dropped downwards from a helicopter without any extraneous control of the block during its fall.

For some purposes however, greater accuracy is necessary than can be obtained with an uncontrolled fall. To increase the accuracy of the positioning of the foundation, according to the present invention the block is caused to move downwards from the helicopter along a guide which extends from the helicopter to the ground below or to a position adjacent the ground below. In most cases it is preferable that the guide should be connected to the ground as it can then form an achorage which assists in locating the helicopter in the position from which the foundation block is caused to move downwards. It is not, however, essential under all circumstances that the lower end of the guide should be fixed. Under particularly still conditions when there is little or no wind, the guide may hang downwards from the helicopter and end a short distance away from the surface of the ground below. In this case the lower end of the guide may be weighted to assist in maintaining it substantially plumb.

The guide may be rigid, it may be jointed at intervals so that it is articulated, or it may be completely flexible, for example in the form of a rope or cable. In general it has so far been found that a flexible guide which is connected to the ground below is most satisfactory and nylon rope has been found to be particularly suitable.

As an alternative, however, a tube made of aluminium or some other light metal may be used. This is termed "rigid" in contrast to a rope which is completely flexible, but it will be understood, however, that a guide in the form of an aluminium tube which may be for example of the order of 1 or 1½ inches in diameter and 200 feet long, will in fact be comparatively flexible and will be able to bow to a considerable extent should

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it be pushed by the helicopter into contact with the ground below.

As already stated the foundation block may be allowed to fall under the action of gravity alone or it may be projected downwards. It is preferable to project the foundation block downwards because then sufficient energy can be gained to cause the block to penetrate the ground to the required depth from a much smaller height than is possible if the block is just allowed to fall. It is obviously desirable to keep the height from which the block is caused to move downwards as small as possible to restrict the length of the guide which is necessary.

The guide may be a single member or single flexible rope to which the foundation block is connected. It may, alternatively, comprise a number of parallel members or ropes between which the foundation block is caused to move downwards. The guide may be connected directly to the ground below by means of a stake driven into the ground or by some other form of anchorage or it may be fixed to an attendant vehicle so that it is thus indirectly connected to the ground.

Where the guide consists of a number of parallel members or ropes the attendant vehicle may have a frame to which the members or ropes are attached so that their spacing is accurately maintained.

More than one foundation block may be caused to move downwards simultaneously from the helicopter and when this is done all the blocks may be connected together by a structure which maintains the positions of the blocks relatively to each other and the blocks are then caused to move downwards along a single guide. The structure connecting the blocks together is destroyed as it strikes the ground and the blocks penetrate the ground independently.

An example of a method of founding a permanent structure in accordance with the invention will now be described by way of example only with reference to the accompanying drawings, in which:—

Figure 1 is a diagrammatic perspective view of a helicopter from which a guide extends downwards to a vehicle on the ground below showing a group of foundation blocks on their passage down the guide;

Figure 2 is a plan as seen in the direction of the arrows on the line II—II in Figure 1;

Figure 3 is a detail to a larger scale of a frame which is fixed to the back of the vehicle shown in Figure 1;

Figure 4 is a cross-section through the frame as seen in the direction of the arrows on the line IV—IV in Figure 3;

Figure 5 is a detail to an enlarged scale showing the attachment of the guide to the helicopter;

Figure 6 is a diagrammatic side elevation of a helicopter with another form of guide extending to the ground below and showing another foundation block moving down the guide;

Figure 7 is a vertical section through a foundation block shown in position on a guide;

Figure 8 is a perspective view of another foundation block showing another form of attachment to the guide;

Figure 9 is a diagrammatic side elevation of a structure supported on the foundation shown in Figures 1 and 2; and

Figure 10 is a side elevation of another structure supported on the foundation block shown in Figure 8.

As shown in Figure 1 a helicopter 1 has suspended below it a guide consisting of four parallel nylon ropes 2. In this particular example the nylon ropes are half an inch in diameter, but this dimension is in no way critical and ropes with widely varying diameters may be used in dependence upon the height from which the foundation is caused to move downwards and also upon the weight and size of the foundation.

The helicopter flies from a depot into position above the position in which a structure is to be founded. A foundation consisting of a main block 3 and four subsidiary blocks 4 is fixed in position underneath the helicopter. The subsidiary blocks 4 are each connected to the main block 3 by a light framework 5. Each of the light frameworks 5 including a ring 6 through which one of the ropes 2, forming the guide, passes.

To the bottom end of the main block 3 are attached three rocket tubes 7. These tubes are spaced at equal intervals around the circumference of the main block 3. When the helicopter is in position above the place in which the structure is to be founded, the lower ends of the ropes 2 are attached to rings 8 fixed on a frame 9 which is attached to the back of a jeep 10. Once the ropes 2 are attached to the rings 8 the helicopter 1 is to a certain extent anchored in position. The pilot then adjusts the position of the helicopter exactly so that the ropes 2 are vertical and are also taut. The length of the ropes 2 will depend on a number of factors which include the weight of the foundation blocks 3 and 4, the nature of the ground in which the foundation is to be formed and the weight of the structure which is to be founded on the foundation blocks.

As explained in our prior Application Nos. 22820/57, 30702/57 and 36703/57 (Serial No. 835,804) the height from which the foundation block is caused to move downwards is determined experimentally. In the case where the main foundation block is fitted with rockets as shown it may be of the order of 150 feet. If the foundation blocks are allowed to fall under gravity alone

the height will be considerably greater and may be of the order of 400 to 500 feet. When the helicopter is in its exact position the main foundation block 3 is released by means of a quick release hook. As the block 3, and the blocks 4 attached to it, start to fall the rockets 7 are fired by pull cords attached to the helicopter. The blocks 3 and 4 are thereupon projected downwards along the ropes 2.

The bottom of the block 3 strikes the ground below the centre of the frame 9 and due to its kinetic energy penetrates the ground. The bottoms of the frames 5 immediately afterwards strikes the ground and the frames 5 being only sufficiently strong to support the weight of the blocks 4 from the block 3 are destroyed so that the blocks 4 are detached from the block 3 and also penetrate the ground in their required positions just outside the periphery of the frame 9. As soon as this has happened the ropes 2 are detached from the rings 8 and the helicopter can return to its depot to pick up a further main foundation block 3 with subsidiary foundation blocks 4 attached to it. At the same time the jeep 10 proceeds to the site in which the next structure is to be founded.

After the foundation has been formed, as just described, an electric transmission line pylon 11 is erected in position (as shown in Figure 9) on the main foundation block 3 and is supported by guy ropes 12 which are attached to the subsidiary foundation blocks 4. The pylon 11 may be erected by a crane on the ground. It may alternatively be lifted by the helicopter 1, either in one piece or in a number of pieces and the piece or pieces are held in position while they are fixed.

Details of the frame 9 are shown in Figures 3 and 4 of the drawings. The frame consists of a tubular ring 13 having a series of radial holes 14 formed through it. The holes 14 are formed at equally spaced intervals around the whole periphery of the ring 13, but only a few of these holes are indicated in Figure 4.

Gusset plates 15 are welded to each side of the ring 13 and to these gusset plates are welded longitudinal members 16. The longitudinal members 16 are in turn welded to brackets, not shown, which are bolted to the chassis of the jeep 10. Each of the rings 8 is attached to a pair of arms 17 which are welded to semi-circular pieces 18. The pieces 18 each have two holes spaced apart at a distance equal to the distance between adjacent holes 14 in the ring 13 so that the pieces 18 can be fixed in any required angular position around the rings 13 by means of bolts 19.

The nylon ropes 2 have a very considerable elasticity and are therefore by themselves able to stand up to the shock loading produced in them when they are attached to the rings 8, by the action of the wind on the helicopter 1. They will also stand up to the loading placed upon them if a part of any of the frames 5 strikes the frame 9 and so tends to tip the jeep 10 and cause a certain jerk on the ropes 2. To reduce the shock loads on the ropes and on the helicopter 1, however, the ropes are connected to the helicopter 1 through spring connections as shown in Figure 5. The top of the rope 2 is connected to an eye bolt 20 fixed to a circular plate 21. From the bottom of the circular plate a tube 22 extends downwards through a circular guide hole 23 in a plate 24 which is fixed to the helicopter 1. The tube 22 is free to slide in the hole 23, but is normally held in its uppermost position by a compression spring 25 which acts on the plate 21 to which the tube 22 is welded. If there is a sudden pull on the rope 2 the plate 21 and the tube 22 are pulled downwards and the spring 25 is compressed. If the tension in the rope 2 is subsequently reduced the spring 25 recovers its previous shape and the plate 21 and the tube 22 are moved back to their original positions.

When only a single foundation block is to be raised to move downwards from the helicopter a guide in the form of a single rope 26 may be used as shown in Figure 6. The top of the rope 26 is attached to the helicopter by the device illustrated in Figure 5 but the bottom of the rope is attached to a ring 27 on a peg 28 which is driven into the ground.

A single foundation block 29 shown in Figures 6 and 7 has a central hole 30 through which the rope 26 passes. As shown in Figure 7 the block 29 has two groups of rollers 31 between which the rope 26 runs. The rollers 31 are not, however, essential and the rope 26 may run directly in the hole 30 and merely slide on the inside surface of this hole. The block 29 is initially attached to the helicopter 1 by a quick release hook in the same manner as is the main block 3 shown in Figure 1. The ring 27 and the peg 28 must be made sufficiently small to pass upwards within the hole 30 between the rollers 31 when the block 29 is dropped to allow the block 29 to penetrate the ground without obstruction. The ring 27 and the peg 28 may alternatively be made of a material which shatters when it is struck by the block 29 although it should have sufficient tensile strength to hold the rope 26 in position.

An alternative to the foundation block 29 having a central hole 30 is the foundation block 32 shown in Figure 8. The block 32 has a socket 33 and two side arms 34 each having a ring 35 at its outer end. With a block such as this the guide consists of

two ropes 36 which pass through the rings 35.

As seen in Figure 10 of the drawings a transmission line pole 37 is erected in position on the foundation block 32 by the insertion of its lower end in the socket 33.

The method of founding permanent structures in accordance with the invention is especially useful for founding pylons or poles carrying electric transmission lines across rough and inaccessible country, but it can also be used for forming many other foundations for various other permanent structures.

WHAT WE CLAIM IS:—

1. A method of founding a permanent structure in soil according to which a foundation block is held by a helicopter in a position above the surface of the soil in which the structure is to be founded, the block is caused to move downwards from the helicopter along a guide which extends from the helicopter to the ground below or to a position adjacent the ground below and the block is caused, by kinetic energy acquired whilst it is in movement above the surface of the soil, to penetrate the soil to a depth at which it is able to carry the load imposed upon it by the structure, and the structure is supported on the block.

2. A method according to Claim 1, in which the guide is connected to the ground and forms an anchorage which assists in locating the helicopter.

3. A method according to Claim 1 or Claim 2, in which the block is projected downwards along the guide by rocket devices fixed to it.

4. A method according to Claim 1 or Claims 2 and 3, in which the guide comprises one or more flexible ropes which are suspended from the helicopter and the lower end of the rope or ropes are connected to an attachment on an attendant vehicle on the ground.

5. A method according to any one of the preceding claims, in which a group of foundation blocks are connected together by a structure and are caused to move downwards simultaneously, the structure being destroyed on striking the ground.

6. A method according to any one of the preceding claims, in which the guide is attached to the helicopter through a spring connection.

7. A method according to Claim 1, substantially as described with reference to Figures 1 to 5 and 9 or Figures 6 and 7 or 8 and 10 of the accompanying drawings.

For the Applicants:—
GILL, JENNINGS & EVERY,
Chartered Patent Agents,
51—52 Chancery Lane,
London, W.C.2.

PROVISIONAL SPECIFICATION.

Improvements relating to Methods of Forming Foundations.

We, THE PRE-STRESSED CONCRETE COMPANY LIMITED, a British Company, of 171 Victoria Street, Westminster, London, S.W.1, do hereby declare this invention to be described in the following statement:—

This invention relates to structural foundations and to a method of forming such foundations in soil. It is an improvement in or modification of the invention described in the Complete Specification accompanying our Applications Nos. 22820/57, 30702/57 and 36703/57 (Serial No. 835,804).

According to one feature of our prior invention, a foundation block is held by a helicopter in a position above the surface of the soil in which the foundation is to be formed and is caused to move downwards from the helicopter and, by kinetic energy acquired whilst the block is in movement above the surface of the soil, to penetrate the soil to a depth at which the block can function as a foundation.

The foundation block may be allowed to fall from the helicopter under the action of gravity alone or it may be projected downwards, for example, by means of a rocket or rockets fixed to it. Considerable accuracy can be obtained in the positioning of a foundation block projected or dropped downwards from a helicopter without any extraneous control of the block during its fall.

For some purposes however, greater accuracy is necessary than can be obtained with an uncontrolled fall. To increase the accuracy of the positioning of the foundation, according to the present invention, the foundation block is caused to move along a guide extending downwards from the helicopter to the ground below or to a position adjacent to the ground. The guide is preferably fixed to the ground so that it forms an anchorage to assist in locating the helicopter as well as guiding the movement of the foundation block downwards.

The guide may be rigid, jointed, or it may be flexible, for example in the form of a rope or cable. If the guide is flexible along its whole length or along part of its length it will hang freely and provided that its weight is sufficient to keep it straight its lower end need not be fixed to the ground. If the guide is too light to be kept straight in

this way its lower end must be fixed so that the guide is tensioned between the ground and the helicopter and so held straight.

When the lower end of the guide is fixed to the ground, the fastening of the guide to the helicopter is preferably arranged so that it permits some vertical movement of the helicopter whilst maintaining the guide under tension. When the guide is a rope, the simplest arrangement is to provide a pulley on the helicopter and the rope passes over this pulley and has a weight equal to the tension required in the rope on its end. The weight hangs down a distance from the pulley equal to the tolerance required in the height of the helicopter.

Instead of using a pulley and weight in this way, a spring or movable hydraulic ram may be used. A spring or ram is satisfactory in all cases whether the guide is flexible or rigid.

When a single foundation block is being dropped by itself, a single tubular guide may be used. Such a guide may consist of a fabric sleeve made for example of nylon. Alternatively the guide in the form of a rope or rod may pass through a hole formed through the foundation block, so that the block runs freely along the guide. The block is preferably provided at each end of the hole with rollers which run on the guide. If a single guide which passes through the foundation block in this way is used, arrangements must be made at the bottom end of the guide where it is fixed to the ground to enable the block to pass over the end fixing. This may be done by anchoring the guide by means of spring loaded jaws. The jaws are moved out of the way against the action of their springs by the foundation block as it moves off the end of the guide and penetrates the ground.

Alternatively, the end of the guide may be held by a light expendable frame-work which is destroyed by the impact of the foundation block. Instead of using a single guide passing through the foundation block two or more parallel guides may be used. When this is done, the foundation block moves downwards between the guides and is provided with projecting arms which run along the guides themselves. In this case, no difficulty occurs at the bottoms of the guides because the foundation block enters the ground between the bottom ends of the guides.

A method of forming a group of two or more foundations, spaced apart from each other by dropping a group of foundation blocks simultaneously is described in the Complete Specification accompanying our prior Applications mentioned above. The present invention is applicable to the formation of a group of foundations in this way and makes it unnecessary to joint the foundation blocks forming the group together by ropes or other flexible attachments.

One or more guides are provided for each foundation block in the group and the guides are fixed to the helicopter by a structure which maintains accurate spaces between them at their upper ends. At their lower ends the guides are similarly accurately fixed to the ground. Each foundation block travels down its associated guide or guides so that the relative positions of the foundation blocks as they enter the ground are accurately controlled.

In some cases, one or sometimes more of the guides for the foundation blocks may be omitted. This is possible where a main central foundation is surrounded by a group of smaller foundations which may be used, for example, for the attachment of guy ropes.

In the case of a central foundation block surrounded by four subsidiary blocks, each subsidiary block may move down a guide and the main central foundation block may be accurately held in position by being attached to each of the four subsidiary blocks.

The lower end of the guide or guides may be fixed to the ground simply by driving in stakes or they may be attached to a structure fixed to an attendant vehicle. When a structure fixed to an attendant vehicle is used, the guide may be fixed to a movable lever arm which is suitably weighted to maintain the required tension in the guide. Under these circumstances, the upper end of the guide may be rigidly fixed to the helicopter.

For the Applicants:—
GILL, JENNINGS & EVERY,
Chartered Patent Agents,
51—52 Chancery Lane,
London, W.C.2.

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862,350 COMPLETE SPECIFICATION

3 SHEETS

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SHEET 1

Fig. 1.

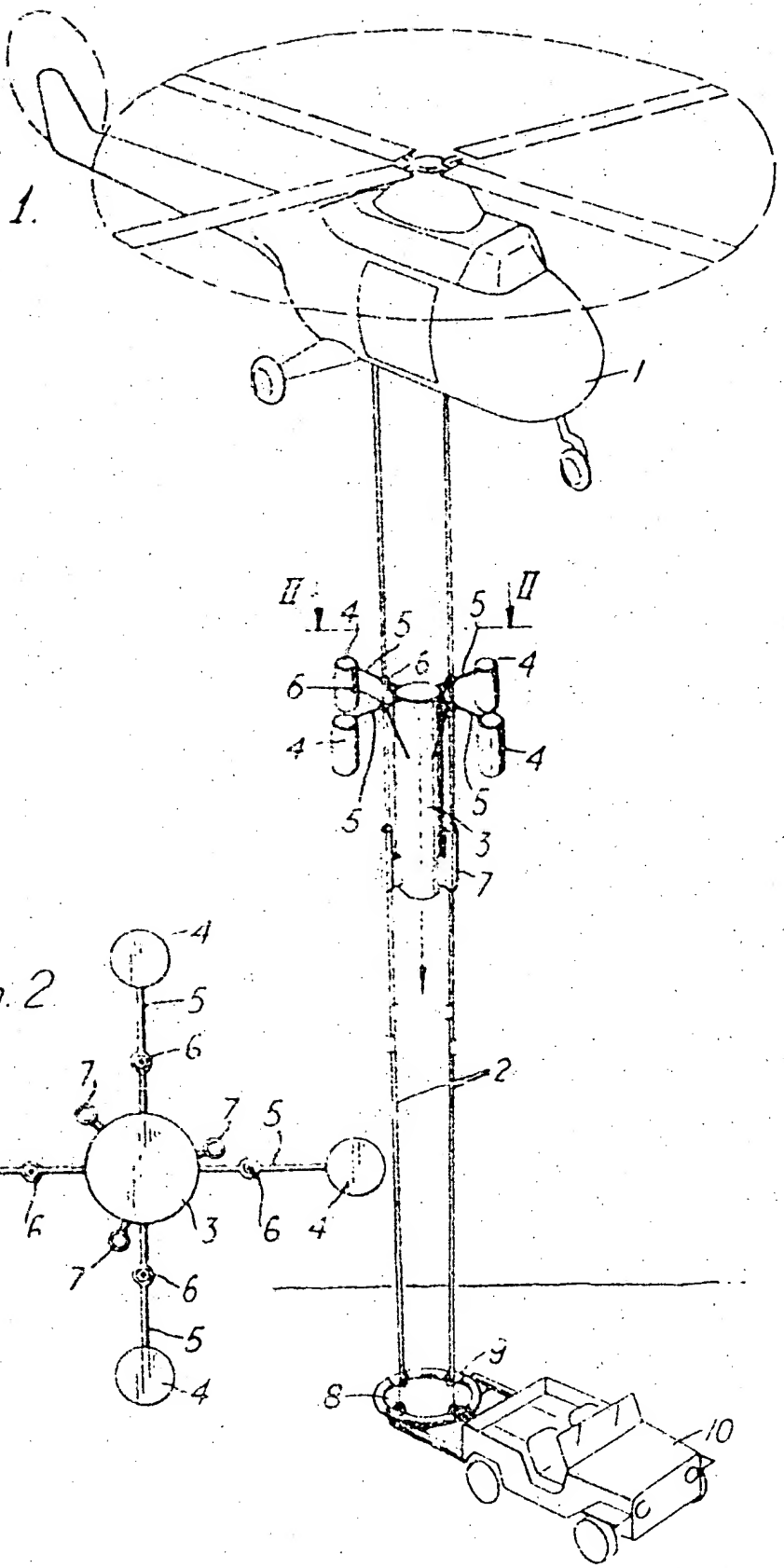


Fig. 2

Fig. 3.

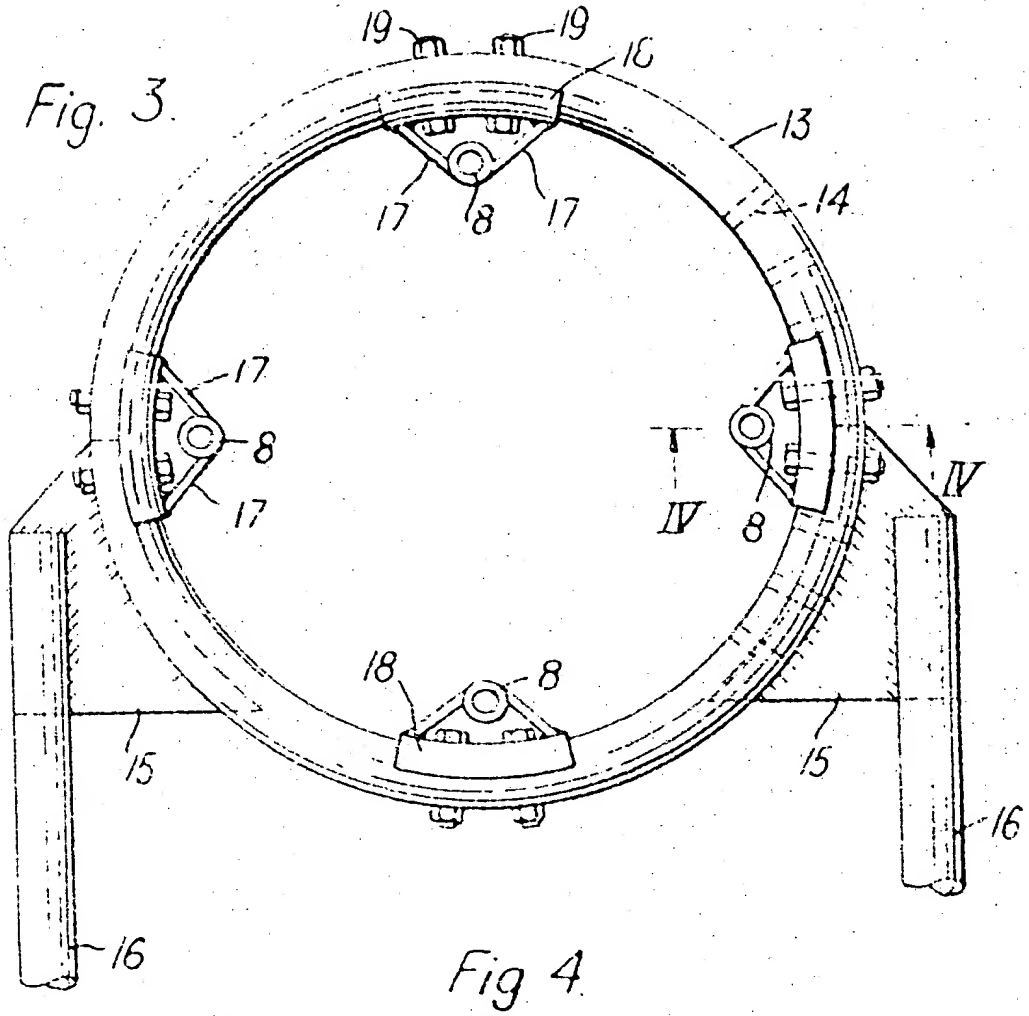


Fig 4.

Fig. 5

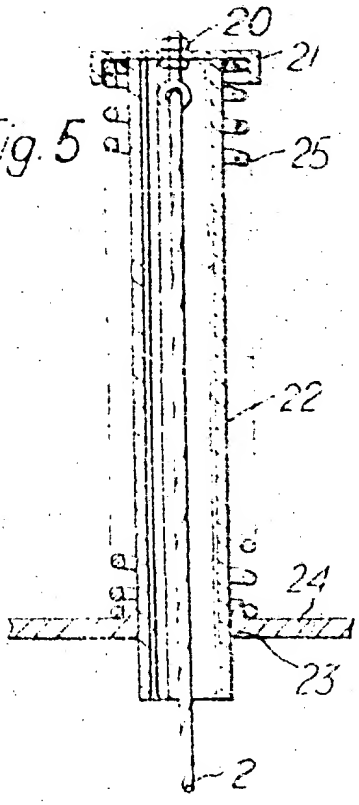
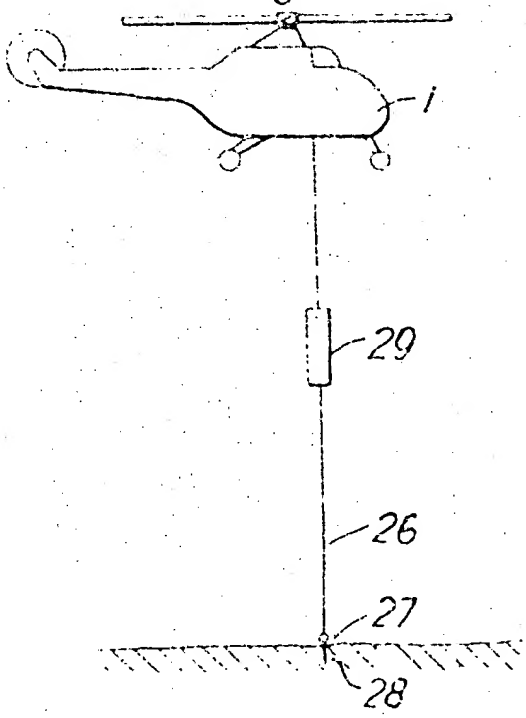


Fig. 6.



862.350 COMPLETE SPECIFICATION

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SHEETS 2 & 3

Fig. 7

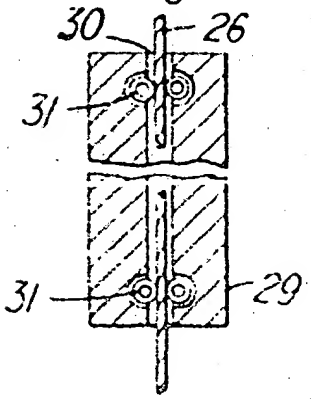

Fig. 8.

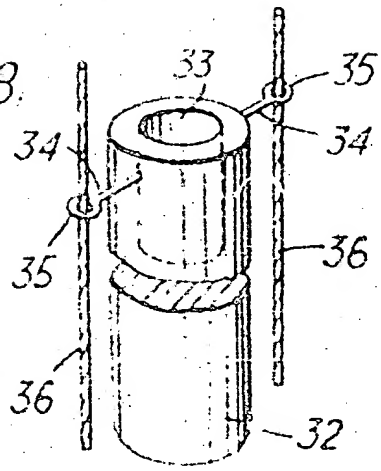

Fig. 9.

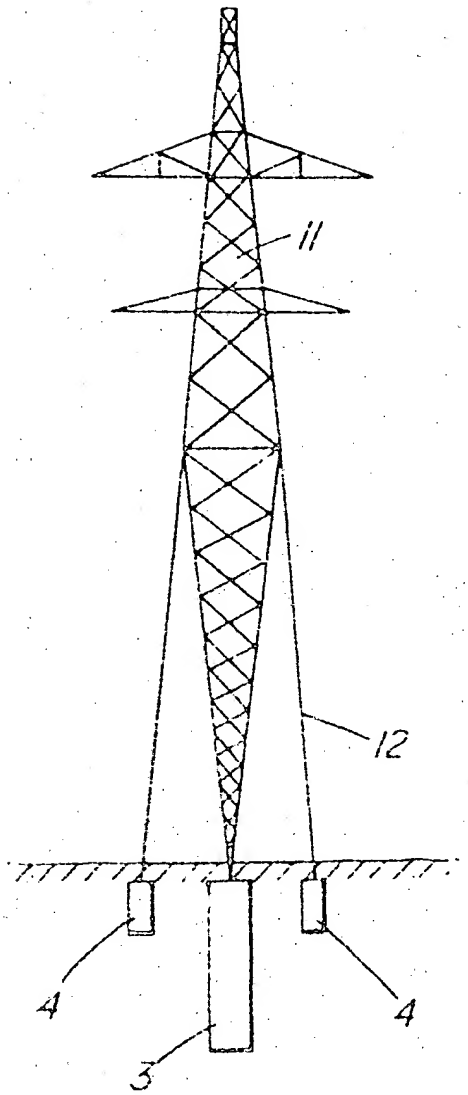

Fig. 10